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FRACTIONATION OF TERRESTRIAL NEON BY HYDRODYNAMIC HYDROGEN ESCAPE FROM ANCIENT STEAM ATMOSPHERES

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Atmospheric neon is isotopically heavier than mantle neon (cf, 1-3). By contrast, nonradiogenic mantle Ar, Kr, and Xe are not known to differ from the atmosphere. These observations are most easily explained by selective neon loss to space; however, neon is much too massive to escape from the modern atmosphere.

Steam atmospheres are a likely, if intermittent, feature of the accreting Earth (4-5). They occur because, on average, the energy liberated during accretion places Earth above the "runaway greenhouse" threshold, so that liquid water is not stable at the surface. We find that steam atmospheres should have lasted some ten to fifty million years (5). Hydrogen escape would have been vigorous, but abundant heavy constituents would have been retained. There is no lack of plausible candidates; CO_2, N_2, or CO. could all suffice. Neon can escape because it is less massive than any of the likely pollutants. Neon fractionation would have been a natural byproduct. Assuming that the initial $^{20}Ne/^{22}Ne$ ratio was solar, we find that it would have taken some ten million years to effect the observed neon fractionation in a 30 bar steam atmosphere fouled with 10 bars of CO (6). Thicker atmospheres would have taken longer; less CO, shorter. This mechanism for fractionating neon has about the right level of efficiency. Because the lighter isotope escapes much more readily, total neon loss is pretty minimal; less than half of the initial neon endowment escapes.

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